

THIS REPORT HAS BEEN DELIMITED
AND CLEARED FOR PUBLIC RELEASE
UNDER DOD DIRECTIVE 5200.20 AND
NO RESTRICTIONS ARE IMPOSED UPON
ITS USE AND DISCLOSURE.

DISTRIBUTION STATEMENT A

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

Armed Services Technical Information Agency

Because of our limited supply, you are requested to return this copy WHEN IT HAS SERVED YOUR PURPOSE so that it may be made available to other requesters. Your cooperation will be appreciated.

AD

40607

NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

Reproduced by
DOCUMENT SERVICE CENTER
KNOTT BUILDING, DAYTON, 2, OHIO

UNCLASSIFIED

AD No. 40607

ASTIA FILE COPY

1

A NOTE ON SATURATION IN THE MICROWAVE SPECTRUM OF METHYL CHLORIDE¹

George R. Bird²
Mallinckrodt Chemical Laboratory
Harvard University, Cambridge, Mass.

¹ This research was supported in part by the Office of Naval Research under Contract N5ori 76, Task Order V.

² Formerly United States Rubber Company Predoctoral Fellow at Harvard University. Present address: Department of Chemistry, The Rice Institute, Houston, Texas.

The saturation of the microwave transition $J = 0 \rightarrow 1$ of CH_3Cl ^{3,5} has been measured by the method of Baird and Bird.³ The results constitute the first

³ D. H. Baird and G. R. Bird, Rev. Sci. Inst. 25, 319 (1954).

measurement on saturation of a rotational absorption line, all other microwave saturation measurements having been made on the $J = 3, K = 3$ line of the ammonia inversion spectrum.^{4,5} As in the case of the ammonia line, the exper-

⁴ B. Bleaney and R. P. Penrose, Proc. Roy. Soc. 60, 83 (1948).

⁵ R. L. Carter and W. V. Smith, Phys. Rev. 73, 1053 (1948).

imental results are described by the formula derived by Karplus and Schwinger.⁶

⁶ R. Karplus and J. Schwinger, Phys. Rev. 73, 1020 (1948).

Their derivation contains the assumption that collisions which broaden the absorption line are identical with collisions which transfer rotational energy and reduce the displacement from thermal equilibrium caused by the absorption of radiation. This corresponds to the case of diabatic (non-adiabatic

or inelastic) collisions, which is expected to apply in the microwave region, but is known not to apply in the visible and ultraviolet regions.⁷

⁷ W. V. Smith and R. R. Howard, Phys. Rev. 79, 132 (1950).

The experimental uncertainty in the actual measurement of the rate of saturation with increasing power is about 30% and is largely due to uncontrollable variations in the standing wave properties of the Stark-effect absorption cell. Reduction of the uncertainty requires the design of a more satisfactory waveguide, and work on this is now in progress. A detailed discussion of the measurements and calculations has been given elsewhere,⁸

⁸ G. R. Bird, Properties of Spectral Absorption Lines, Doctoral Thesis, Harvard University, 1952.

and will not be repeated.

The line breadth constant $\frac{\Delta\nu}{P}$ has been measured for each of the three quadrupole fine structure lines of this transition and found to be 21 ± 1 mc./mm. Hg at 300°K, a result largely independent of the errors which enter into the saturation measurements. The intensity of the strongest line ($J = 0 \rightarrow 1$, $F = 3/2 \rightarrow 5/2$) is revised to $7.9 \cdot 10^{-6} \text{ cm}^{-1}$ from the figure of $6.6 \cdot 10^{-6} \text{ cm}^{-1}$ calculated by Kisliuk and Townes⁹ for an assumed line breadth of 25 mc./mm. Hg.

⁹ P. Kisliuk and C. H. Townes, Molecular Microwave Spectra Table, National Bureau of Standards Circular 518, June 23, 1952, p. 26.

If the line-broadening interactions are idealized as hard-sphere collisions, a collision diameter of 16.1 \AA may be calculated. This is much greater than the value of 5.6 \AA obtained from viscosity measurements and the kinetic theory

of gases.¹⁰ The large size of the microwave collision diameter indicates that

¹⁰ J. H. Jeans, The Dynamical Theory of Gases, Cambridge, England (1916), p. 295.

dipole-dipole interactions are the principal mechanism for line-broadening and rotational energy transfer.

The author gratefully acknowledges the help and encouragement of Prof. E. Bright Wilson, Jr. A K-band thermistor and W-bridge/^{were} kindly loaned by Dr. A. G. Hill of the Research Laboratory of Electronics, M.I.T.

Armed Services Technical Information Agency

Because of our limited supply, you are requested to return this copy WHEN IT HAS SERVED YOUR PURPOSE so that it may be made available to other requesters. Your cooperation will be appreciated.

AD

40607

NOTICE: WHEN GOVERNMENT OR OTHER DRAWINGS, SPECIFICATIONS OR OTHER DATA ARE USED FOR ANY PURPOSE OTHER THAN IN CONNECTION WITH A DEFINITELY RELATED GOVERNMENT PROCUREMENT OPERATION, THE U. S. GOVERNMENT THEREBY INCURS NO RESPONSIBILITY, NOR ANY OBLIGATION WHATSOEVER; AND THE FACT THAT THE GOVERNMENT MAY HAVE FORMULATED, FURNISHED, OR IN ANY WAY SUPPLIED THE SAID DRAWINGS, SPECIFICATIONS, OR OTHER DATA IS NOT TO BE REGARDED BY IMPLICATION OR OTHERWISE AS IN ANY MANNER LICENSING THE HOLDER OR ANY OTHER PERSON OR CORPORATION, OR CONVEYING ANY RIGHTS OR PERMISSION TO MANUFACTURE, USE OR SELL ANY PATENTED INVENTION THAT MAY IN ANY WAY BE RELATED THERETO.

Reproduced by
DOCUMENT SERVICE CENTER
KNOTT BUILDING, DAYTON, 2, OHIO

UNCLASSIFIED